of which stand available for educational cooperation and research—you will not only deserve and win the applause of a grateful community, but you will blaze the way for a reform imperatively needed in other medical colleges. Modern medicine must provide a training for the practice of the public health no less rigorous than that for the practice of medicine; for the public health is the health of the people, and, as the Latin phrase puts it, *Salus populi suprema lex.*

A PRELIMINARY STUDY OF THE PHYSIOLOGICAL EFFECTS OF HIGH TEMPERATURES AND HIGH HUMIDITIES IN METAL MINES.

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Introduction.

One of the most important problems encountered in present-day metal-mining practice is that of providing efficient ventilation, especially in those mines which have high air temperatures and high relative humidities in extensive workings at considerable depths, or in workings where mine fires are found or where there is much oxidation of timber or of ore. It has long been recognized that mine workers subjected to hot, humid, stagnant air and to certain harmful dusts in many of our metal mines contract miners' consumption and possibly other diseases; and although considerable study has been made of the effects of dusts, temperatures, and humidities in mines of England,[1] South Africa, and of some European countries,[2] very little of this kind of study has been done in the United States, especially as regards the effect of high temperatures and high relative humidity in our mines.

The following study was made in two comparatively deep copper mines, both with fairly high temperatures and humidities, one in which practically no attempt at ventilation was made and one with a ventilation system of a much more efficient nature than is generally found in metal mines. In both mines the data were taken at points over 2,000 feet below the surface and with surrounding rock temperatures generally in excess of 90° F.

In general, the following data were taken: Surface air temperatures and relative humidities and body temperature, blood-pressure readings, pulse, time of day. Data taken underground at each place visited included temperature and humidity readings of air in working places, occasionally rock and water temperatures, temperature of compressed-air blowers, air movement or velocity, kind of work being performed, exact time of day, number of workers, and bodily tem-

[1] Haldane Journal of Hygiene, Vol. V, pp. 494, 1905.
[2] Oliver: Diseases of Occupation.

perature, blood pressure, pulse rate, and other data, of those persons on whom or by whom the experimental work was being done. The following instruments were used: Sling psychrometer for air, rock, and water temperatures, and for relative humidity; Davis anemometer for air velocities; Tycos sphygmomanometer, aneroid type (checked at intervals with a mercury instrument), for obtaining blood pressures; and 2-minute Tycos clinical thermometers for taking body temperature. All readings on persons were taken with the subjects standing.

Investigations in Mine No. 1.

On three consecutive days the investigators entered a mine (designated No. 1) for purpose of taking data as to effect of high temperatures and high relative humidity in stagnant air, there being no attempt at ventilation of the mine other than from compressed-air blowers which, however, furnished sufficient air to prevent excessive vitiation. On the first day, data were taken on five subjects, A, B, C, D, and E; and on the two succeeding days, on A, B, and C. No work was done other than to walk slowly a few thousand feet underground and to take the necessary readings as to temperature, humidity, velocity, and blood pressure, and in only one instance did the investigators leave the level to climb a few feet into a stope. While underground, A was dressed in heavy woolen underwear and trousers; B, C, D, and E were dressed in light cotton underwear, knee-length light trousers. A was about 40 years of age, weight 120 pounds; B about 36 years, weight 150 pounds; C about 32 years, weight 150; D about 28 years, weight 160; and E about 32 years, weight 160. D and E were accustomed to perform nearly all kinds of work underground in hot mines; whereas A, B, and C were not, although they were well accustomed to spending much time underground on investigative work.

Table I gives compiled data as to readings taken on the three days in Mine No. 1, and an inspection of that table shows that the investigators were in the hot region 120 minutes on the first day, 90 minutes on the second, and 115 minutes on the third (it had been the intent to remain underground at least four or five hours each day, but the effect of the hot, humid, stagnant air was so great that the investigators were physically unable to remain underground much longer than the length of time given). It is significant that although A, B, and C had been accustomed to go underground regularly prior to making this investigation, yet at the end of the three days, during which time a total of but 5 hours and 25 minutes were spent underground doing only such light work as walking on level ground and taking temperature, blood pressure, and other readings, A lost 6 pounds and B lost over 5 pounds in weight, and C, though he did not weigh, lost perceptibly in weight, and all were seriously fatigued each day after leaving the mine.

TABLE I.

Location.	Time in minutes after entering mine.	A.				B.				C.				D.				E.				Air conditions.				Compressed air blowers.			Rock temperature.	Water temperature.
		Systolic.	Diastolic.	Body temperature.	Pulse.	Systolic.	Diastolic.	Body temperature.	Pulse.	Systolic.	Diastolic.	Body temperature.	Pulse.	Systolic.	Diastolic.	Body temperature.	Pulse.	Systolic.	Diastolic.	Body temperature.	Pulse.	Wet bulb.	Dry bulb.	Relative humidity (per cent).	Velocity.	Wet bulb.	Dry bulb.	Relative humidity (per cent).		
FIRST DAY.																														
On surface	....	118	78	98.8	....	....	....	99.8	....	110	76	99.4	.....	108	76	99.6	....	116	70	99.6	....	52	58	66	.....	.....	.....	.....	.....	.....
Face of crosscut	20	116	78	.....	....	....	....	99.8	108	106	74	101.2	100	106	76	100.0	114	114	78	100.0	90	96	97½	94	None..	82	94	60	97½	97
Face of drift	80	112	68	.....	140	....	....	101.8	120	104	64	101.6	120	106	62	102.0	118	110	78	102.0	100	95	96	96	...do...	73	91	41½	.....	.....
2,500-foot station	110	104	62	.....	120	....	....	102.6	140	106	68	102.6	120	106	60	102.0	138	102	58	102.8	120	92½	93½	96	...do...	86	86	100	.....	.....
On surface 10 minutes before bath	130	96	58	.....	144	....	....	102.6	140	92	48	102.4	128	82	42	.....	....	80	40	102.2	106	58	69½	49	Slight.	.....	.....	.....	.....	.....
SECOND DAY																														
On surface	....	106	78	99.3	98	96	72	99.3	90	98	72	99.4	72	....	....	.....	....	.....	.....	.....	.....	55	61	68	Still...	.....	.....	.....	.....	.....
2,400-foot station	10	106	82	.....	108	96	78	.....	90	98	76	.....	88	....	....	.....	....	.....	.....	.....	.....	92	92½	98	None..	.....	.....	.....	.....	.....
Intersection SW. and main ledge	60	112	88	100.8	138	92	70	100.2	124	94	76	100.4	112	....	....	.....	....	.....	.....	.....	.....	94	94¾	97	...do...	78	92	53	....	94½
On surface 10 minutes	100	96	68	101.3	112	88	72	100.6	96	90	68	101.6	[1] 108	....	....	.....	....	.....	.....	.....	.....	57½	69½	48	Slight.	.....	.....	.....	.....	.....
On surface 1 hour	160	96	78	99.1	92	96	78	99.6	88	94	72	100.5	[2] 76	....	....	.....	....	.....	.....	.....	.....	57½	69½	48	...do...	.....	.....	.....	.....	.....
On surface 2½ hours	190	112	86	98.3	108	98	76	98.8	96	110	82	98.9	[3] 82	....	....	.....	....	.....	.....	.....	.....	57½	69½	48	...do...	.....	.....	.....	.....	.....
THIRD DAY.																														
On surface	....	108	72	98.3	104	98	76	98.8	96	98	70	98.6	72	....	....	.....	....	.....	.....	.....	.....	55	67	48	Still...	.....	.....	.....	.....	.....
Face NW. drift	40	104	68	99.8	124	98	82	99.2	100	94	70	99.2	80	....	....	.....	....	.....	.....	.....	.....	91	91½	98	None..	.....	.....	.....	91	.....
2,300-foot station	110	102	68	102.5	142	90	68	100.6	128	98	62	101.2	130	....	....	.....	....	.....	.....	.....	.....	92½	92½	100	...do...	81	86	81	.....	.....
On surface 10 minutes	125	98	74	100.9	138	90	70	100.6	118	88	68	101.7	[4] 120	....	....	.....	....	.....	.....	.....	.....	60½	79	32	Still...	.....	.....	.....	.....	.....
On surface 20 minutes	145	88	68	100.9	128	98	74	100.2	96	92	66	100.5	[5] 104	....	....	.....	....	.....	.....	.....	.....	60½	79	32	...do...	.....	.....	.....	.....	.....
On surface 2 hours	245	112	78	98.3	108	112	84	99.2	96	112	78	99.1	[3] 98	....	....	.....	....	.....	.....	.....	.....	60½	79	32	...do...	.....	.....	.....	.....	.....

[1] No bath taken to-day. Before eating. [2] After eating. [4] Before bath. [5] After bath.

During the three days in Mine No. 1 there was no period at which the investigators were in a temperature (either wet or dry bulb) less than 90° F. (and in many cases the dry bulb reading was above 95° F.), and at all times there was absolutely no perceptible movement of air except that which could be obtained immediately in the current of the compressed-air blowers. Even the compressed-air blowers (see also Table I) had dry-bulb temperatures above 85° F., and in many cases they were over 90° F., the temperatures being taken at the end or nozzle of the compressed-air hose. Although the compressed-air temperatures were nearly as high as those of the surrounding air, yet the high velocity and the comparatively low humidity of the direct current gave at least a temporary measure of relief, and this constituted the only available relief from the extremely depressing conditions.

Table I shows that blood pressure fell decidedly when the subjects were exposed to stagnant, humid air with temperatures over 90° F. and below 100° F., and that a decided fall in blood pressure was found immediately upon reaching cooler, purer air of the surface after having been exposed for about two hours to the above-described unfavorable conditions. For considerable time after reaching the surface the rise in blood pressure was slow, even when the subjects took a hot shower bath with a finishing dash of cold water; it was not until after eating, one to two hours later, that blood pressure rose, and then it jumped somewhat higher than before the subjects went underground. It is noted, too, that blood pressures taken on the surface before going underground on the first day were higher than similar readings taken under similar conditions on the second and third days, probably indicating at least a temporary depression of general vitality after having been underground.

Body temperature rose at the rate of approximately 1° F. per hour on exposure to stagnant air with wet and dry bulb temperatures between 90° and 97° F., even when no work was being done other than leisurely walking along level haulage roads. This increase of body temperature continued until 102.8° F. was reached in one case and approximately 102° F. in the other cases, or fever temperatures throughout. After having been underground for about two hours under conditions described above, temperature decrease took place in still surface air about 70° F. and 50 to 60 per cent relative humidity, at the rate of about 1° F. per hour, apparently being comparatively little influenced by a hot shower bath followed by a final dash of cold water.

Pulse increased rapidly upon entering and remaining in this hot humid air, and after having been in this atmosphere for about two hours doing little or no work as above described, it had reached as high as 130 and occasionally 140 or over. Upon returning to the

surface a comparatively rapid decrease of pulse rate was noticed; however it did not reach the same rate as that before going underground for several hours. In general, pulse rate was high in the hot, humid, stagnant air, and it seemed to be abnormally sensitive to even the slightest exercise. It was found to rise rapidly even in the case of subjects who had been accustomed to hard work under such conditions, as well as in the subjects of this experiment.

During the first day all five subjects stated that they felt dizzy within 20 minutes after entering the hot, humid, stagnant air, and within an hour all felt weak. B was very nervous after an hour's exposure, and later had alternate hot and cold sensations; C had a dull headache; and all subjects perspired very freely; all appeared unable to think quickly or accurately after less than one hour's exposure. On reaching the surface, all felt well except B, who was very weak for about 15 minutes; all complained of feeling somewhat weak the remainder of the day, and A, B, and C did not sleep very well that night, but D and E, more accustomed to hard physical work, slept well.

On the second and third days only A, B, and C went underground, and the symptoms experienced on these days were similar to those felt on the first day, but in a somewhat milder degree. However, after the three days' experimentation in which a total of less than five and one-half hours was spent underground, the exhausting effect of stagnant, humid air with temperatures between 90° and 97° F. was shown in the fact that A and B (C not weighing) each had lost over 5 pounds in weight, though no work was done of a more arduous nature than leisurely walking in unobstructed level drifts.

Table II contains some observations made on five miners who volunteered, all being healthy, robust men except V, who was pale and thin (he had worked 14 years in this mine). While underground these men dressed in shoes and trousers or overalls usually cut off just above the knees. Underwear or shirts were not worn. The first set of readings was taken before the men went underground, the second was taken underground at the shaft station just prior to hoisting the men after having worked their shift, and the third was taken 25 minutes after the men had reached the surface, and all except V had taken their shower bath. No temperature readings were taken.

It will be noted that except in case of Z, blood pressure had fallen perceptibly after 7½ hours underground in humid, stagnant air with temperatures between 90° and 95° F.

Blood pressure reacted practically to normal in the cases of W and Z after shower bath, these two men having worked in this mine 11 days and 4 months, respectively; and in case of X, who had worked 12 days, blood pressure had increased perceptibly after the

TABLE II.

Location.	Time between readings, in hours.	V.[1]			W.[2]			X.[3]			Y.[4]			Z.[5]			Air conditions.		
		Systolic.	Diastolic.	Pulse rate.	Systolic.	Diastolic.	Pulse rate.	Systolic.	Diastolic.	Pulse rate.	Systolic.	Diastolic.	Pulse rate.	Systolic.	Diastolic.	Pulse rate.	Wet bulb.	Dry bulb.	Relative humidity (per cent).
On surface		116	82	78	132	86	96	142	92	80	116	72	72	118	76	78	55	61	68
2,400-foot station	7½	92	66	124	122	92	104	92	68	118	104	70	120	116	78	108	92½	92½	100
On surface 25 minutes	8¾	88	64	108	134	92	118	116	82	108	92	66	116	118	80	96	60½	79	32

[1] Readings as to V were taken previous to bathing; as to others, after bathing. V had worked 14 years on hot levels.
[2] W had worked 11 days on hot levels.
[3] X had worked 12 days on hot levels.
[4] First day that Y had worked in the mine in 6 months.
[5] Z had worked 4 months on hot levels.

bath. On the other hand, in the case of Y, who had worked his first day underground in 6 months, blood pressure had fallen perceptibly after the bath, apparently indicating that workers who were accustomed to the conditions had acquired a certain tolerance or at least were not as sensitive as were persons unaccustomed to the conditions. But in the case of V, who did not bathe after returning to the surface, there was a slight drop of blood pressure. He had worked in this mine 14 years, was pale and thin, but was active and apparently was not physically exhausted by 7½ hours underground to the same extent as were the other more robust men. His work is much less arduous than that of the other men, as he is a shift boss.

The pulse rate had risen perceptibly by the time the men had spent seven and one-half hours underground, and, except in case of W, fell quickly after the men reached the surface. W showed a pulse rate increase as well as increase of blood pressure after reaching the surface. However, after having been on the surface practically one-half hour after the end of the underground shift, the pulse rate remained perceptibly above normal in every case.

These men, with the exception of Z, stated that they were weak at the end of the shift, and Y said he was weak and dizzy several times during the shift. All said that they felt well, even if slightly weak, after they had taken the shower bath. Men in this mine work wear practically no clothing, and while underground they drink large quantities of water, which is brought there in kegs and kept cooled in ice. Miners who wear underclothing underground are frequently seen wringing the perspiration out of it. A surveyor in this mine stated that after two or three hours' work in the hot, humid, stagnant places in this mine in the forenoon, he and his assistants sleep the entire afternoon as well as the night, in order to be physically able to spend a like two or three hour shift the next day. Shift bosses who have worked some years in this mine state that they frequently feel dizzy and weak after taking even moderate exercise, such as climbing a ladder into a stope. These shift bosses are invariably pale and thin; they state that they have much less endurance than formerly, and that they "take things easy" and allow the men under them to do likewise. A cage tender who practically divides his working time between the surface and the hot, stagnant shaft stations of lower levels, stated that after eight months of such work he had lost 20 pounds. Three men quitting work after one shift appeared weak; two of them said they were dizzy, and one said he felt nauseated.

Notwithstanding the obviously unhealthful conditions in this mine, the miners present a generally robust and healthy appearance. This is probably due to three main reasons: First, knowing the conditions, the foreman employs only very strong, healthy looking men; second, the men are never hurried or rushed by the shift boss, and, in fact, are

told to "go easy" and "take five" frequently; third, men employed continuously in the hot, humid, stagnant air generally remain for only a few months. It was stated by the foreman that at least 50 per cent of the men employed worked one shift or less, but that if they can last a week they usually remain several months. Though the monthly labor turnover was over 100 per cent, plenty of men were available, as the mine is located close to the heart of a large mining community. The men are expected to work a seven instead of the customary eight hour shift, for which they receive 25 cents per day more than employees of neighboring mines with an eight-hour shift; and, as before stated, the workers are rarely if ever hurried by the bosses.

The efficiency of the workers is somewhat difficult to gauge; yet it is certainly much less than 50 per cent of that of similar workers in other mines. At working faces, while one machine man or mucker works, his companion rests in the full stream of a compressed-air blower, the men exchanging places at intervals of 20 to 30 minutes and *frequently both rest.* Moreover, the man working the short interval at the face must work at reduced pressure; for instance, two men at the face of a drift in this mine in still air, with 96° F. wet bulb and 94 per cent relative humidity, muck about 12 tons per shift; whereas in a drift in an adjoining mine, less than 1,000 feet away, in *moving air,* with 82° F. wet bulb and 82 per cent relative humidity, two men muck 30 tons or over per shift. The average of about 30 readings taken at all working faces of this mine gave wet bulb 93.3° F., dry bulb 94.4° F., and a relative humidity of 96 per cent, and at no place was there any perceptible movement of air except at points close to compressed-air blowers. However, while the resultant conditions were undeniably depressing, little or none of this effect was attributable to air impurity as little or no smoke was encountered, and analyses of air samples taken at working faces showed little or no vitiation, the large amount of compressed air from blowers apparently keeping the quality of the air good but not being of sufficient quantity to give the necessary velocity to cause cooling by evaporation.

Investigations in Mine No. 2.

A second series of readings was taken on two days in Mine No. 2, a deep mine with extensive workings. This mine, while more efficiently ventilated than most metal mines, has high rock temperatures, and practically any desired condition as to temperature, humidity, and air movement is obtainable. In this mine the workers are supplied with fresh city water at a temperature of about 65° F., and they say that they can drink large quantities of the water without ill effect. The men generally work in a suit of underwear, trousers, and shoes, and upon leaving the mine put on a woolen shirt and a heavy coat.

TABLE III.

Location.	Time, in minutes, after leaving surface.	A.				B.				C.				D.				Air conditions.		
		Systolic.	Diastolic.	Temperature.	Pulse rate.	Systolic.	Diastolic.	Temperature.	Pulse rate.	Systolic.	Diastolic.	Temperature.	Pulse rate.	Systolic.	Diastolic.	Temperature.	Pulse rate.	Wet bulb.	Dry bulb.	Relative humidity (per cent).
On surface	000	112	76	98.4	108	102	76	99.6	96	106	76	99.4	84	118	78	98.6	90	55	67	45
Face of X cut	10	108	72	99.7	120	106	80	100.0	96	102	74	100.0	88	114	82	100.0	96	94½	97½	89
Do	25	112	68	99.8	122	107	82	100.0	120	100	74	100.0	100	112	82	100.0	120	94½	97½	89
Do	45	108	72	101.5	134	108	84	100.6	132	100	74	100.9	108	102	68	100.2	128	94½	97½	89
Do	70	98	68	101.8	136	98	78	101.4	130	100	76	101.5	128	108	68	102.6	122	94½	97½	89
Canvas air pipe	95	106	82	100.9	120	.....	.....	101.2	.....	106	78	101.8	112	.....	.....	.....	.....	82	89½	72
On surface 10 minutes	165	100	72	100.5	130	101	72	100.6	120	102	74	101.0	98	106	84	100.0	92	58	80	23
On surface 2.3 hours	295	106	80	.....	.....	100	72	99.6	100	110	76	.....	76	.....	.....	.....	.....	.....	.....	.....

A, B, C, and D entered Mine No. 2 about two weeks after completion of the readings in Mine No. 1, and spent over an hour the first day at the face of an abandoned crosscut in practically stagnant air, wet bulb 94½° F., dry bulb 97½° F., and relative humidity 89 per cent. All were dressed essentially the same as they were in the investigation in Mine No. 1, and on this first day (see Table III), A, B, and C remained practically at rest for about 70 minutes. There was comparatively little change in blood pressure during the first 45 minutes in this atmosphere *at rest*, except that the blood pressure of D fell. At the 70-minute reading the blood pressures of A and B had fallen perceptibly, though there was little or no change as to the blood pressure of C; and D, who was the youngest and perhaps the most vigorous of the four, had slightly increased blood pressure as compared with the 45-minute reading, which was probably due to slight exercise taken just previous to the last reading.

On this day the body temperature of the four investigators at rest at the face of the crosscut had risen slightly during the first 10 minutes after they had entered the place, and had risen perceptibly at the readings 45 and 70 minutes after entering, reaching a maximum of 102.6° F., in D at the 70-minute reading, he having carried a light ladder about 50 feet during the interval between the 45 and 70 minute readings. The maximum body temperature of A, B, and C (101.8°, 101.4°, and 101.5°, respectively) was reached at the 70-minute reading, and none of these men had exerted himself in the slightest degree, other than to take readings of temperature, blood pressure, etc. Pulse rate had started to rise slightly at the reading 10 minutes after entering the hot, humid, still atmosphere, and continued to rise at the 25, 45, and 70 minute readings, except that in case of B and D there was a slight fall in pulse beat between the 45 and 70 minute readings.

After having remained practically at rest 70 minutes at the face of this abandoned crosscut, in stagnant air 97½° F. and 89 per cent relative humidity, all perspiring freely and having increased body temperature and pulse rate and decreased blood pressure, the men walked about 200 feet to a point where air was being discharged from the end of a canvas tube at a rate of 2,300 linear feet per minute, this air having a temperature of 82° wet bulb, 89½° dry bulb, and a relative humidity of 80 per cent. A, B, and C stopped at the end of this pipe, and D went out to the shaft station. A sat with his head in the direct air current about 3 feet from the end of the canvas tube; B sat at one side somewhat out of the current; and C sat out of the current for 12 minutes and partly in the air current for 3 minutes. At the end of 15 minutes A's temperature fell from 101.8° to 100.9° F., pulse rate fell from 136 to 120, blood pressure rose from 98 to 106 systolic,

and from 68 to 82 diastolic. Meanwhile B, sitting a few feet distant in *still* air with essentially the same temperature and humidity as that of the *moving current* in which A sat, had only a slight bodily temperature decrease of from 101.4° to 101.2°, showing the decided influence of *air movement* even when the air had high temperatures. C, also sitting near A, but within the direct air current only 3 minutes, showed slight increase of bodily temperature, but had a marked rise in blood pressure and a very definite fall in pulse rate.

As in similar readings in Mine No. 1, there was a definite fall in blood pressure immediately upon reaching the surface, with subsequent slow increase and a return to normal after a good meal had been eaten.

Table IV gives data as to the effect of doing moderate work in an abandoned stope of mine No. 2, 3 floors down from 2,800-foot level, in practically stagnant air, with wet bulb 85½° to 86° F. and relative humidity about 96 per cent—a condition typical of blind-end drift, crosscut, and stope faces in many deep mines. The four subjects remained practically at rest the first 55 minutes, the only effort being that due to climbing down from timber to timber for about 25 feet from the level to the stope below, this effort being reflected in the slightly increased bodily temperature and pulse rate at the 15-minute reading.

Just previous to the 65-minute reading, A and D started to exercise by climbing up and down ladders, B and C remaining at rest. A, who weighed 120 pounds, climbed up and down an 8-foot ladder 15 times in 5 minutes after taking the 55-minute reading; the 65-minute reading shows a slight *increase* in blood pressure, a decided increase in bodily temperature (from 99.5° to 100.3° F.), and an equally great increase in pulse rate. Just after the 65-minute reading, A again climbed up and down the 8-foot ladder 15 times in 5 minutes, and at the 85-minute reading his blood pressure had again risen slightly while temperature had risen from 100.3° to 100.9°, but the pulse remained at 128. D, who weighed 160 pounds, climbed the 8-foot ladder up and down 3 times in 40 seconds, starting immediately after the 55-minute reading (this allowed about 8 or 9 minutes rest before taking the 65-minute reading), and he showed practically no change in blood pressure or temperature, though his pulse rate jumped from 96 (which he had held uniformly while at rest during the first 55 minutes) to 108. Immediately after the 65-minute reading he again climbed up and down the 8-foot ladder 3 times in 40 seconds and rested about 18 minutes before the 15-minute reading, which again showed very little change of bodily temperature or blood pressure, but an increase of pulse rate from 108 to 132.

In this series of readings it is noticeable that there was comparatively little drop in blood pressure or increase in bodily temperature

TABLE IV.

Location.	Time in minutes after entering mine.	A.				B.				C.				D.				Air conditions.		
		Systolic.	Diastolic.	Body temperature.	Pulse rate.	Systolic.	Diastolic.	Body temperature.	Pulse rate.	Systolic.	Diastolic.	Body temperature.	Pulse rate.	Systolic.	Diastolic.	Body temperature.	Pulse rate.	Wet bulb.	Dry bulb.	Relative humidity (per cent).
On surface	000	106	66	98.7	102	108	78	99.8	86	102	74	99.4	84	124	80	99.4	90	59½	64½	74
Stope, 3 floors down from level	15	110	80	99.6	108	104	78	99.8	120	98	74	99.3	80	118	78	100.0	96	85½	86½	96
Do	35	105	78	99.4	96	102	78	99.9	98	100	76	99.6	84	116	78	99.4	96	85½	86½	96
Do	55	104	82	99.5	96	100	78	99.9	104	98	76	99.7	84	114	82	99.4	96	85½	86½	96
Do	65	108	80	100.3	128	.....	.....	.....	.....	.....	.....	.....	.....	116	80	99.4	108	85½	86½	96
Do	85	110	84	100.9	128	.....	.....	.....	.....	.....	.....	.....	.....	112	84	99.4	132	85½	86½	96
Do	105	.....	.....	.....	.....	100	72	99.9	100	96	72	99.8	86	.....	.....	.....	.....	86	87	96
On surface 10 minutes	140	104	72	100.5	104	106	78	99.9	92	98	74	99.8	84	118	80	99.4	80	61	78	36

or pulse rate as long as the four investigators remained quiet in the still air with temperature 85½° to 86° F. wet bulb and relative humidity 96 per cent. When light work was done, such as climbing up 24 feet of vertical ladder and then down, with 8 to 18 minutes rest before taking readings, there was little or no perceptible change of blood pressure or of bodily temperature, but a definite increase of pulse rate. On the other hand, when 120 feet of vertical ladder was climbed up and down in five minutes, with 3 to 14 minutes' rest before taking a reading, although blood pressure was affected only slightly, there was a perceptible increase in bodily temperature. As climbing up and then down 120 feet of vertical ladder in 5 minutes can not be called very strenuous work it would seem that any attempt at actual sustained performance of hard work under the above conditions would result in high body temperatures. Upon coming to the surface, all subjects gave readings that were almost normal, this being true of blood pressure and pulse rate and of bodily temperature in all but A, whose bodily temperature remained over 100° F., owing presumably to his having exercised somewhat more strenuously than his companions. None of the subjects experienced any unusual symptoms except A, who thought he became tired more easily than usual.

The above study, involving readings on a few men for a few days, and under comparatively little diversity as to conditions, is at best inconclusive, and it is recommended that much additional data be obtained in order to ascertain the effect on the human system of working in hot, humid, stagnant air, such as is so frequently found in our metal mines. Data should also be obtained as to the effect of hard work in cool mines on blood pressure, bodily temperature, pulse rate, etc.; and similar data should be ascertained for air with various temperatures, wet and dry bulb, and still as well as moving air, together with data on the effect of various kinds of mine air impurities, such as CO_2, and the lack of oxygen on the human system.

Summary.

I. In still air in metal mines, with a wet bulb temperature over 90° F. and under 100° F., and with a relative humidity of 89 per cent or higher, the following signs and symptoms were found, even when little or no exercise was taken:

1. Blood pressure, systolic and diastolic, fell rapidly.
2. Body temperature rose; in one case it reached 102° F., and this after less than two hours having been spent in the hot, humid air described.
3. Pulse rate increased and seemed more sensitive to exercise than normally.
4. Perspiration was very profuse.
5. Dizziness was a common symptom, and sometimes was marked.

6. Physical weakness or exhaustion was marked in some cases and present in all.

7. Inability to think quickly or accurately was a very common symptom.

8. Nausea was occasionally found.

9. Headache was also occasionally found.

10. Loss of weight was especially marked in men who had been employed under above conditions over a period of years, but occurred even after exposure only a few days.

II. In still air, with wet bulb temperatures of from 85° F. to 86° F. and a relative humidity of 96 per cent, there were no marked changes in the blood pressure or body temperature, nor were the symptoms dizziness, physical weakness, and inability to think or act quickly, mentioned in I, found as long as the subjects remained at rest or took only light exercise. When moderate exercise was taken—climbing up and down an eight-foot ladder fifteen times in five minutes—the blood pressure and body temperature rose somewhat.

III. Blood-pressure readings taken after the subject had reached the cool air of the surface were found to vary considerably with men unaccustomed to high temperatures. Under conditions which resulted in a rise of body temperature to 100° F., or more, the systolic pressure fell, but where the conditions were such as not to cause the body temperature to rise above 100° F., there was a rise in the systolic pressure when the subjects reached the surface. In one man, long accustomed to hot, humid air, a fall of systolic pressure was also found. In three others, not accustomed to the conditions mentioned, there was a rise of systolic pressure.

IV. It was found that the body temperatures reached normal in from one to two hours after the subjects had reached the cool air of the surface after having been subjected to conditions that caused a rise above 100° F.

V. It was noted that a shower bath, beginning with tepid water and ending with a dash of cold water, had but little immediate effect upon the body temperature.

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INDEX TO PUBLIC HEALTH REPORTS, VOL. 35, PART 1, 1920.

The index, with title page, to Vol. 35, Part 1 of Public Health Reports for 1920 is now available and may be had on application to the Surgeon General, United States Public Health Service, Washington, D. C.